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## **IBM 7320 Drum Storage with IBM 7090-7094-7094 II Systems**

This bulletin presents general information about the IBM 7320 Drum Storage as used with the IBM 7090-7094-7094 II systems. A working knowledge of the 7090-7094-7094 II systems is assumed.

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This edition, Form A22-6747-1 obsoletes Form A22-6747 and N22-0089. Significant changes have been made throughout this manual; this edition should be reviewed in its entirety.

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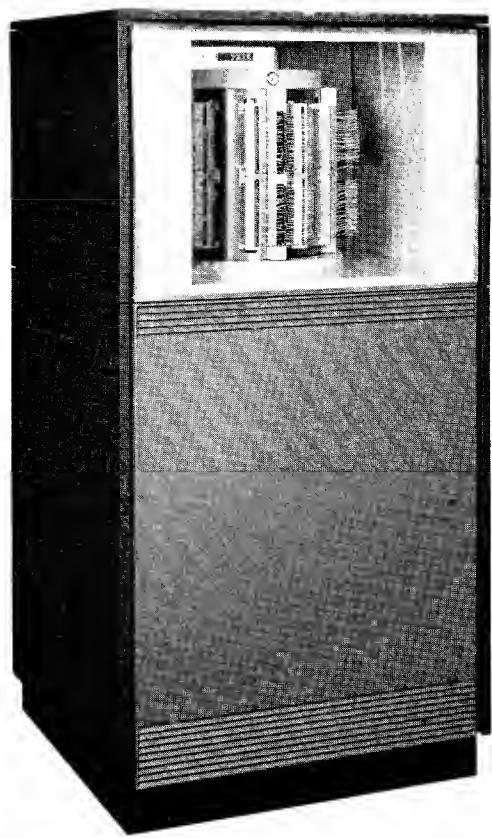


Figure 1. IBM 7320 Drum Storage



Figure 2. IBM 7631 File Control

## IBM 7320 DRUM STORAGE WITH IBM 7090-7094-7094 II DATA PROCESSING SYSTEMS

High data transmission rates to and from the IBM 7090-7094-7094 II Data Processing Systems and elimination of "seek time" to both randomly and sequentially stored information are provided by the IBM 7320 Drum Storage (Figure 1). Intended primarily for use with the higher data capacity IBM 1301 and 1302 Models 1 and 2. Disk Storage units, the lower capacity, higher speed 7320 Drum Storage complements a disk-oriented random access storage subsystem to produce highly efficient random and sequential data processing facilities, permitting expanded programming versatility, reduced systems loading time and operations, and greater data channel utilization.

### APPLICATIONS OF DRUM STORAGE

With the associated IBM 7631 File Control unit (machine serial number of 12,000 or higher) Models 2 or 4 (Figure 2), the 7320 substantially contributes to the following data processing functions and applications in 7090-7094-7094 II operations:

Program and Reference Table Storage: Systems Program Residence - IBSYS Basic Monitor, IBJOB Processor, FORTRAN Compiler, etc.

Operational Systems Residence: Subroutines, error recovery routines, mathematical function tables, rate tables, etc.

Indexing Facilities for Larger Capacity Storage Units: Disk storage indexing operations, tape indexing operations, etc.

High-Transaction-Frequency/Low-Data-Volume  
Activities: Reduces need for extensive searching and batch processing operations.

Intermediate (Scratch) Storage Facility: For large problem storage extension, program interrupt data, check point and restart procedures, etc.

Temporary Storage Facility: For master files, compacted programs, preprocessed input data.

The following table shows some characteristics of the IBM 7320 Drum Storage as used in the 7090-7094-7094 II systems.

|  |           |
|--|-----------|
| Number of Addressable Data Tracks per Drum           | 400       |
| Number of Cylinders per Drum                         | 10        |
| Number of Tracks per Cylinder                        | 40        |
| Data Track Record Capacity                           |           |
| 6-bit Characters*                                    | 3,180     |
| 36-bit Words**                                       | 530       |
| Maximum Data Capacity per Drum                       |           |
| 6-bit Characters*                                    | 1,272,000 |
| 36-bit Words**                                       | 212,000   |
| Maximum Data Capacity per Cylinder                   |           |
| 6-bit Characters*                                    | 127,000   |
| 36-bit Words**                                       | 21,200    |
| Character Transfer Rate (per second)                 |           |
| 6-bit Characters                                     | 202,800   |
| Access Motion Time                                   | 0         |
| Average Rotational Delay (milliseconds)              | 8.6       |
| Maximum Number of 7631-File Control Units per System | 2         |

\* Adjusted for 6-character, 36-bit fixed-length words used in 7090-7094-7094 II operation.

\*\* Based on HA2 of six characters.

## DRUM STORAGE OPERATION

The 7320 Drum Storage consists of a vertically mounted drum and its associated electronic circuitry. The drum, coated with a magnetic recording material, rotates at about 3,500 revolutions per minute. The surface of the drum is divided into tracks. These addressable tracks, extending around the periphery of the drum, are used for storing data, format organization, and drum control purposes as follows:

|          |                         |
|----------|-------------------------|
| 400      | Standard Data Tracks    |
| 1        | Standard Format Tracks  |
| up to 40 | Alternate Data Tracks   |
| up to 2  | Alternate Format Tracks |

The alternate tracks are provided to insure that each recorded bit can be stored in a magnetically perfect medium. If a defect is encountered on a track, the entire track is disabled and one of the alternate tracks is substituted. This alternate track is given the address of the disabled track.

Each standard data track has its own read/write head, used for both recording and retrieving data. The data read/write heads are fixed in position on 20 vertical racks that surround the drum. Each rack contains 20 data read/write heads. The read/write head for the format track is also mounted on one of the vertical racks. If required, heads are readily moved, by the customer engineer, from disabled tracks to one of the alternate tracks.

The read/write heads contain tiny, coil-wrapped magnetic cores. During writing operations, these cores convert electrical signals, received from the computer, into magnetic flux to magnetize defined spots on the drum surface. During reading operations, the action is reversed; the magnetized spots on the drum surface generate a magnetic flux. This flux is converted to an electrical signal by the read/write head and transmitted to the computer.

### DATA ACCESS TIMES

Because of the assignment of an individual read/write head to each standard data track, data seek operations, with their associated access motion time delay, are eliminated. Two interrelated modes of data access are involved in drum storage operation as compared to three in disk storage operation. One access mode is mechanical and the other access mode is electronic.

Figure 3 shows a simplified drum module depicting several data tracks and associated read/write

heads. As shown, rotational delay time ( $T_R$ ) is the only time-consuming factor involved in drum storage operations. Rotational delay ( $T_R$ ) is the time required for the particular record on the rotating drum to come under the read/write head.  $T_R$  is a variable from zero to 17.4 milliseconds, the full rotational duration of the drum. Because  $T_R$  will vary, an average rotational delay of 8.6 milliseconds is generally used in drum timing calculations.

The selection of the proper read/write head is electronic and is performed during rotational delay time. Read/write head selection time ( $T_E$ ) is so negligible, it is generally considered nonexistent.

### DRUM CYLINDERS

Arrangement of read/write heads on vertical racks permits the organization of data to be stored in "cylinders" of data. Cylinder operations with drum storage units allow up to 40 tracks to be written on or to be read with a single drum storage order. Cylinder mode of operation with the 7320 is provided by the cylinder mode optional feature in the 7631 File Control and furnishes compatibility between the 7320 and up to ten cylinders of the 1301/1302 Disk Storage units.

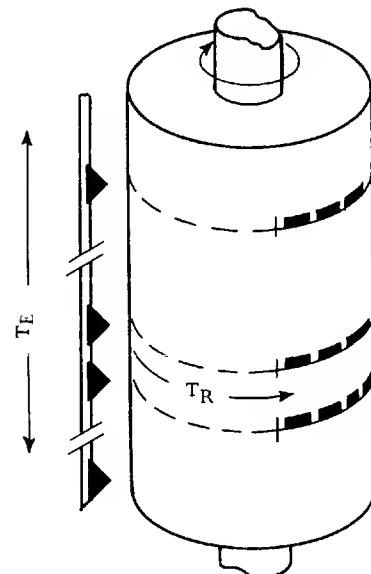


Figure 3. Simplified Drum Storage-Access Modes

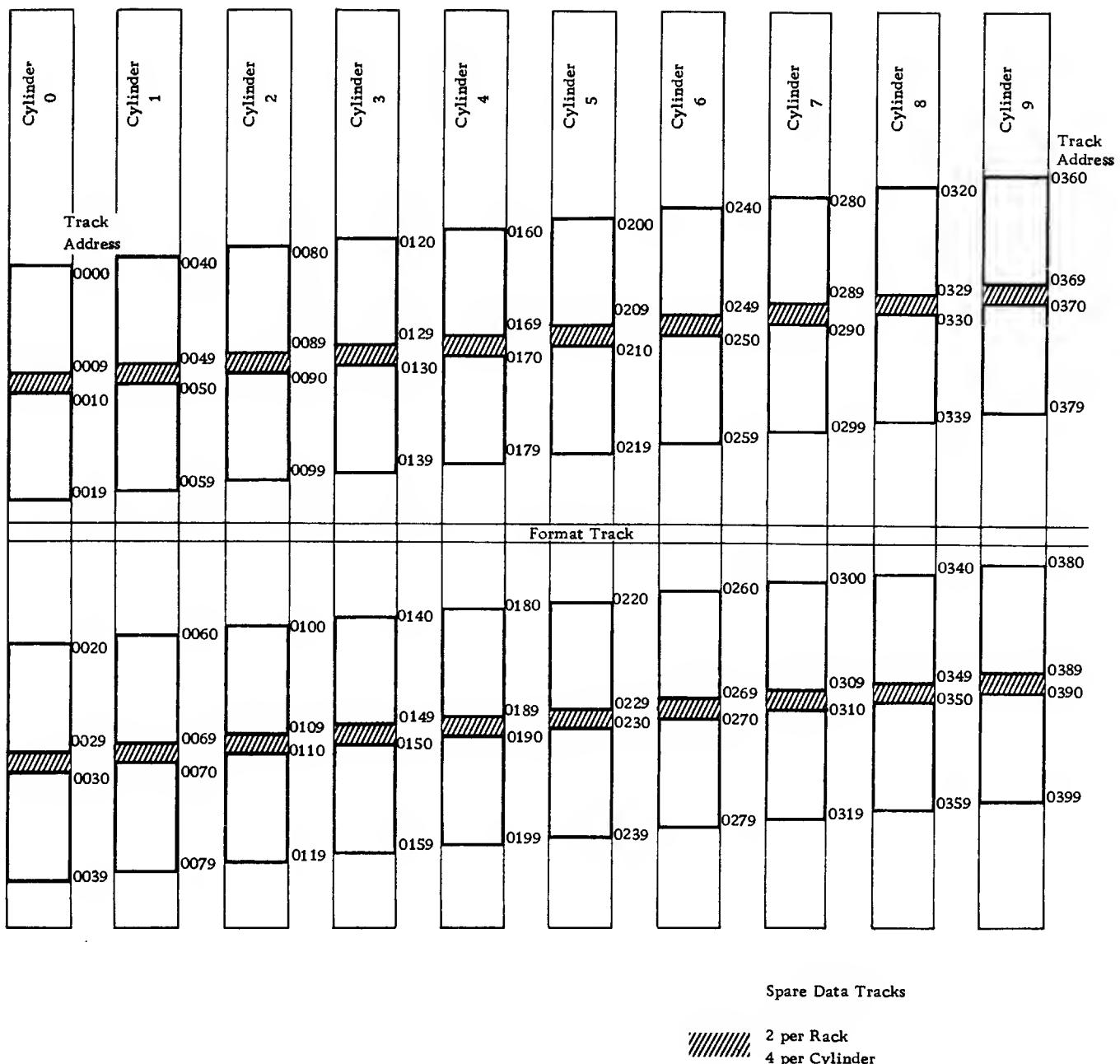


Figure 4. Track and Cylinder Layout, IBM 7320 Drum Storage

A cylinder in a 7320 is defined as a group of 40 tracks as follows:

| Cylinder | Track Numbers |
|----------|---------------|
| 0        | 0000 to 0039  |
| 1        | 0040 to 0079  |
| 2        | 0080 to 0119  |
| 3        | 0120 to 0159  |
| 4        | 0160 to 0199  |
| 5        | 0200 to 0239  |
| 6        | 0240 to 0279  |
| 7        | 0280 to 0319  |
| 8        | 0320 to 0359  |
| 9        | 0360 to 0399  |

Cylinder mode of operation can start at the beginning of any track within a cylinder and proceed until processing of the cylinder is completed or until the computer issues a stop signal whichever comes first. No wrap-around feature is included in cylinder operation to cause operation to restart at the low-order read/write head after the high-order head has completed its reading or writing operation.

Figure 4 shows the layout of tracks and cylinders for the 7320.

#### MODULE NUMBERING

A maximum of five 7320 Drum Storage units may be attached to a 7090-7094-7094 II Data Processing System. The module number for each drum storage unit is determined by the fixed assignment of cable connectors between the IBM 7631 File Control unit and the attached drum storage unit.

| 7631 Cable Connector | Drum Module |
|----------------------|-------------|
| First                | 0           |
| Second               | 2           |
| Third                | 4           |
| Fourth               | 6           |
| Fifth                | 8           |

#### DATA TRACK ADDRESSING

To address a particular data track out of the maximum possible total of 2,000 (five 7320 Drums), it is necessary to specify the following:

|              |  |
|--------------|--|
| Module       | 0, 2, 4, 6, or 8   |
| Access       | 0 (access number in drum storage is always 0)                                    |
| Track Number | 0000-0399 (internal circuitry will select the specific read/write head involved) |

#### DATA TRACK ORGANIZATION

The basic recording area of the drum storage unit is the data track; however, the entire recording area of

track cannot be used exclusively for data storage. Certain identifying information must be recorded on the track before its use as a record storage area. On subsequent read or write operations, this information is used by the machine to identify the track and each of the record areas reserved for data storage on that track.

A data track and the data to be written or read from a track are identified by means of a home address 1 (HA1), a home address 2 (HA2) and as many record addresses (RA) as there are record areas to be established on the data track (Figure 5).

#### Home Address 1 (Track Number)

Home address 1 (HA1) is the first information on each data track and follows the index point for that track. It is a four-digit number and is the actual physical address (0000-0399) of a track. The high-order digit (always zero) is used for 7320-1301/1302 compatibility and in address comparison operations. The track number is prerecorded in each data track and cannot be written by the user.

#### Home Address 2 (Home Address Identifier)

Home address 2 (HA2), which follows HA1 in each data track, is the home address identifier. It consists of two or more characters (numeric, alphabetic, or special) written by the user, in six-bit mode on the 7090-7094-7094 II. Although the home address identifier can be greater than two characters in length, only the first two characters are compared in address verification in operations. (Address verification is the confirmation that the correct track location has been reached.) In subsequent references to HA2, in general, only the first two characters are considered.

HA2 must be written on the data track by the user before actual writing or reading operations are performed on that track. From an addressing or reference viewpoint, the combined HA1 and HA2 become the actual address of a data track in a module; HA2 provides a method by which the user is able to further define the address of each data track. This identification of a track, in subsequent recording and retrieval operations, must indicate both the pre-recorded HA1 address and the HA2 address established by the user.

In addition to its use as the home address identifier, the HA2 address can serve other useful purposes. For example, HA2, incorporated as part of



Figure 5. Drum Track Address and Data Arrangement

the track address, can be used as a coded file protection device. That is, in using this file protection scheme, a HA1 address without a proper HA2 address will not allow a data track to be referenced.

#### Record Address

The data track storage area, following the HA1 and HA2 addresses, is one long continuous area for the data storage. How this space is to be organized, the number of records to be stored, the number of characters in each record, and how each record area is to be identified are determined solely by the user. Operations necessary to accomplish layout (format) of data must be performed before the data track can be used for reading or writing. The manner in which this is accomplished is discussed in "Format Track."

Each record area established for a data track is preceded by a record address (RA) (Figure 5). The record address consists of 6 or more characters, which may be numeric, alphabetic, or special characters. They are assigned and written by the user to fit any convenient addressing scheme. A record address need not have any relationship to the home address of the track where it is written. When the record address (6 characters) is verified, only the numeric portion (4 low-order bits) of the first 4 characters is verified. All bits of the last 2 characters are checked during address verification operations. Characters of a record address exceeding 6 in number are not verified. Because of the ability of the 7320 Drum Storage to store different length records, highly efficient use of drum storage and flexibility of data organization are provided.

#### Data Records

Records on a data track can be of any length, from a minimum of 2 characters to the full length of the data track, less necessary character spaces for a home address, record address, and required gaps.

#### Data Track Gaps

The gaps on the data track following the information areas are required for machine control and code checking purposes. As each information area of the drum is being written, HA1, HA2, record addresses, records, and machine check information are automatically generated and placed in the gap following the area being written. As each of these information areas is read in subsequent operations, new check characters are automatically generated and compared, bit-for-bit, with the check characters placed in the gap when the information area was written. If they do not compare, an error is indicated.

Note: The track index is used as a machine reference point on the track; that is, it indicates both the beginning and the end of the track. The track index is used by the 7631 file control in conjunction with the file control-drum storage synchronizing functions.

#### DATA RECORDING

Information is recorded on a drum track serially by character and serially by bit. A space bit separates characters within a record.

Information to be written on drum is transferred, character-by-character, from core storage to the 7631. An odd-bit parity check is performed on each character. A space bit is inserted and the character is written on the drum. During reading, information is read from the drum, character-by-character. The space bit is removed, an odd parity is generated, and the character is sent to core storage.

#### Data Track Capacity

Each data track on the 7320 Drum Storage has a capacity of 3,230 six-bit character positions for recording information. (This figure has been adjusted to compensate for the character positions used in the prerecorded home address 1 (HA1) and accompanying gaps for the home address.) To determine the number of character positions available for storing data records, the character positions required for HA2, the record addresses, and the additional required machine gaps must be considered.

The maximum number of data characters that can be recorded on a data track in 7090-7094-7094 II operation can be calculated as follows:

$$3,230 - HA2* - n(RA** + 38) = 3,180 \text{ maximum (six-bit)}$$

where:  $n$  = number of records per track

\*HA2 - normally six characters for 7090-7094-7094 II operation

\*\*RA - minimum of six characters

The constant of 38 characters is used to accommodate all machine gaps relating to records. Note: 7320 records must be a minimum of 2 characters in length.

The following table shows the number of records per track for different record lengths and the remaining number of character positions that can be used, as desired, by the program. To calculate the size of additional record(s) that can be placed in the remainder of a track, subtract 44 from the remainder. (The 44 consists of 6 characters for the record address and 38 characters used as a constant.)

Variable Record Length Formula and Partial Capacity Table--Six-Bit Characters

$$\frac{3224}{\text{Record Length} + 44} = \text{No. of records per track}$$

| Record<br>Length<br>(Characters) | Record<br>Length plus<br>Record Address<br>(Characters) | Records per<br>Track | Track<br>Remainder<br>(Characters) |
|----------------------------------|---|----------------------|------------------------------------|
| 6                                | 50  | 64                   | 24                                 |
| 12                               | 56  | 57                   | 32                                 |
| 18                               | 62  | 52                   | 0                                  |
| 24                               | 68  | 47                   | 28                                 |
| 30                               | 74  | 43                   | 42                                 |
| 60                               | 104   | 31                   | 0                                  |
| 90                               | 134   | 24                   | 8                                  |
| 120                              | 164   | 19                   | 108                                |
| 240                              | 284   | 11                   | 100                                |
| 360                              | 404   | 7                    | 396                                |
| 480                              | 524   | 6                    | 80                                 |
| 720                              | 764   | 4                    | 168                                |
| 1440                             | 1484  | 2                    | 256                                |
| 1800                             | 1844  | 1                    | 1380                               |
| 2400                             | 2444  | 1                    | 780                                |
| 2800                             | 2844  | 1                    | 380                                |
| 3000                             | 3044  | 1                    | 180                                |
| 3180                             | 3224  | 1                    | 0                                  |

## FORMAT TRACK

The advanced characteristics of the IBM 7320 Drum Storage permit the user flexibility in establishing drum storage space to be allocated, organized, and addressed. While this flexibility of drum storage use makes possible a wide variety of storage formats to meet the needs of many applications, it also requires that the user organize the drum storage in some particular format before its use as a data storage device. These activities can be compared to wiring a control panel for unit record machines, to house-keeping preparations for a program, or to masking a storage area for future use. For understanding drum storage, it is important that the operations required for establishing the format of drum storage are not confused with the operations related to the use of drum storage.

Before any data can be written on or read from a data track, a format track for the drum storage must be written. One format track is used for the 400 tracks of the 7320 Drum Storage.

### Function of the Format Track

The function of the format track is to control the use of the data tracks of the drum. Once a format track has been written, it establishes the location, character size, and mode of reading or writing which can take place in the home address area, the record address areas, the record areas, and certain gap areas. Data

to be written on or read from each data track must conform to the format established by the format track.

The layout and writing of the format track are under the complete control of the user. Once written, however, the format for a drum remains fixed until the format track is rewritten.

To prevent unintentional changes to the information recorded on the format tracks, each drum module is provided with a two-position key-lock switch. A format track can only be written upon when the switch is in a Write position. The switch is normally placed in a Read position.

## Format Track Control Characters

The control characters used to write a format track must first be organized in core storage as a record (format control record). The prepare to write format order followed by a write command transfers the core storage format control record to the 7631 File Control. It is converted to a special bit configuration for machine control purposes, and it is written on the format track. Since the format track defines, in machine form, the control action previously defined in core storage format control record, explanation of how the data tracks of a drum are organized will be made in terms of the core storage format control record.

Four different characters, BCD 1, 2, 3, and 4, compose a format control record in core storage. The BCD characters 1 and 2 define data track areas that will be handling data in a six-bit mode. The BCD characters 3 and 4 define data track areas that will be handling data in an eight-bit mode. (When used in 7090-7094-7094 II, the 7320 normally operates in six-bit mode. However, Gap1, HA1, and Gap2 in core storage format layout are recorded in eight-bit mode.)

Note: Certain areas of the format track are used for machine control and data checking purposes. These areas must be provided unconditionally in the core storage format control record.

Figure 6 shows a typical core storage layout of a format control record for 7090-7094-7094II operation.

### Format Track Arrangement

The core storage format control record is transmitted to the specified format track by appropriate programming. In 7320 Drum Storage operation, one format track is used for all 400 data tracks. Figure 7 shows format track arrangement and associated field number information.

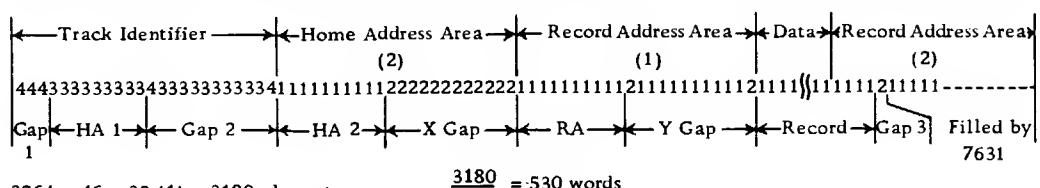
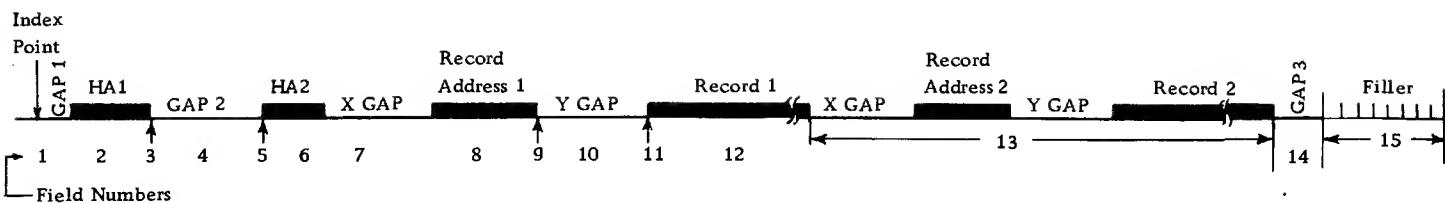


Figure 6. Format Track Core Storage Layout (Single Record)



The field numbers with accompanying information are:

| Field Number | Number Characters   | Digit Used | Comments  |
|--------------|---|------------|---|
| 1            | 3   | 4          | Pre-HA1 timing gap (Gap 1)  |
| 2            | 9   | 3          | This field defines home address 1 (HA1)   |
| 3            | 1   | 4          |   |
| 4            | 10  | 3          | Pre-HA2 timing gap (Gap 2)  |
| 5            | 1   | 4          |   |
| 6            | 10  | 1          | This field defines home address identifier 2 (HA2)  |
| 7            | 12  | 2          | Pre-RA timing gap (Gap X)   |
| 8            | 10  | 1          | This field defines the record address (RA)  |
| 9            | 1   | 2          |   |
| 10           | 10  | 1          | Pre-record timing gap (Gap Y)   |
| 11           | 1   | 2          |   |
| 12           | 7 + L   | 1          | This field defines the record area. Seven characters are for machine requirements   |
| 13           | Fields 7 through 12 are repeated for each additional record area required |            |   |
| 14           | 1   | 2          | This timing gap field follows only the last record area on a track (Gap 3)  |
| 15           | As needed   | 1          | This field is used when necessary with fixed word length computers to fill out the last format word in core storage (7090-7094-7094 II-7040-7044) |
| 15**         | Minimum of 11   | -          | This field is automatically generated by 7631 for machine requirements  |

L = Number of characters in record area  
 \* 1's or 2's are used for six-bit mode, 3's or 4's are used for eight-bit mode in Gap 1, HA1, Gap 2.  
 \*\* This field is never in core storage; it appears only on the format track

Figure 7. Format Track Arrangement--7320

## IBM 7631 FILE CONTROL UNITS

### **7090-7094-7094 II SYSTEMS REQUIREMENTS**

A maximum of five IBM 7320 drum modules may be attached to a 7090-7090-7094 II system through one or two IBM 7631 File Control units. File control units with a machine serial number of 12,000 or higher are required for 7320 operation. The Drum Storage Adapter, Feature #3451, must be installed in the 7631 for drum storage operation.

The 7631 is available in two models, Model 2 and 4, for 7090-7094 and 7094 II operation and can be used as control units for the IBM 1301 Disk Storage, Models 1 and 2; the IBM 1302 Disk Storage, Models 1 and 2; and the IBM 7320 Drum Storage. These storage units may be intermixed in any fashion up to a maximum of five storage units per 7631 File Control unit. The optional feature "Cylinder Mode," Feature #3213, installed on the 7631 serves all combinations of disk/drum cylinder mode operations. The 7631 File Control, Model 2, is used in single system disk/drum storage operations.

The 7631 File Control, Model 4, is used in shared system disk/drum storage operations. The 7631 Model 4 permits the storage and retrieval of data in disk and/or drum storage units physically attached to any combination of two of the following IBM Data Processing Systems: IBM 7070-7074, 7080, 7090-7094-7094 II, 7040-7044.

Notes: 1. IBM 1302 Disk Storage, Models 1 and 2, are not available for use with the 7070 Data Processing System.

2. IBM 7320 Drum Storage is available only on the 7040-7044, 7090, 7094, and 7094 II Data Processing Systems.

Figure 8 shows one possible configuration of 1301-1302/7320 units in shared system operation between a 7040 and a 7090 Data Processing System.

### **FUNCTIONS OF 7631 FILE CONTROL**

The 7631 File Control performs a variety of functions in a drum storage processing operation. Some of these functions are:

1. Decode and execute orders transmitted from the computer main storage to the drum storage by way of data channels.
2. Assemble and disassemble, as required, characters transmitted between the computer and drum storage.
3. Perform data and program checking (parity checking, address verification, invalid operation codes, error detection, etc.) of information received from or going to the computer.

4. Provide monitoring services and allied programmed interrogation and program interrupt between the drum storage and the attached computer by the use of communication signals to indicate various drum storage processing conditions. Some of these monitored conditions are: file control receipt of a transmitted order, successful or unsuccessful execution of a drum operation, and indication of the status of the several drum modules.

### Communication Signals

In the continual communication between drum storage and the computer, three types of monitoring signals are transmitted from the drum storage-file control subsystem back to the computer, and one signal is transmitted from the computer to the file control-drum storage subsystem. These signals are: end, unusual end, attention, and stop.

End: The end signal is issued by the 7631 File Control and is transmitted to the computer to indicate compliance with an order sent to drum storage. The end signal indicates that the order has been received and decoded and that execution has resulted in the successful completion of the order.

Unusual End: The 7631 checks for 12 error or unusual conditions possible in drum storage operation. The occurrence of any of these conditions (see Error and Unusual Conditions) causes the issuance of an unusual-end signal. Causes of the unusual-end signal are recorded in the 7631 File Control circuitry. This recorded information, known as status data, can be transmitted to the computer main storage for stored program interrogation. The status data are retrieved from the 7631 by the use of a data channel sense command, which is similar to a read command except only ten 4-bit characters are transmitted to the computer.

Sense data words are used to transmit the status data and may consist of up to two sense words--incorporating both error-condition indications and attention indications, as listed. If an unusual-end signal is generated by the 7631 and the computer is not programmed to issue a sense command to retrieve the recorded status data, the status data will be lost upon the issuance of the next data channel command.

Attention: In 7320 Drum Storage operation, the attention signal is used primarily for compatibility purposes with 1301-1302 Disk Storage.

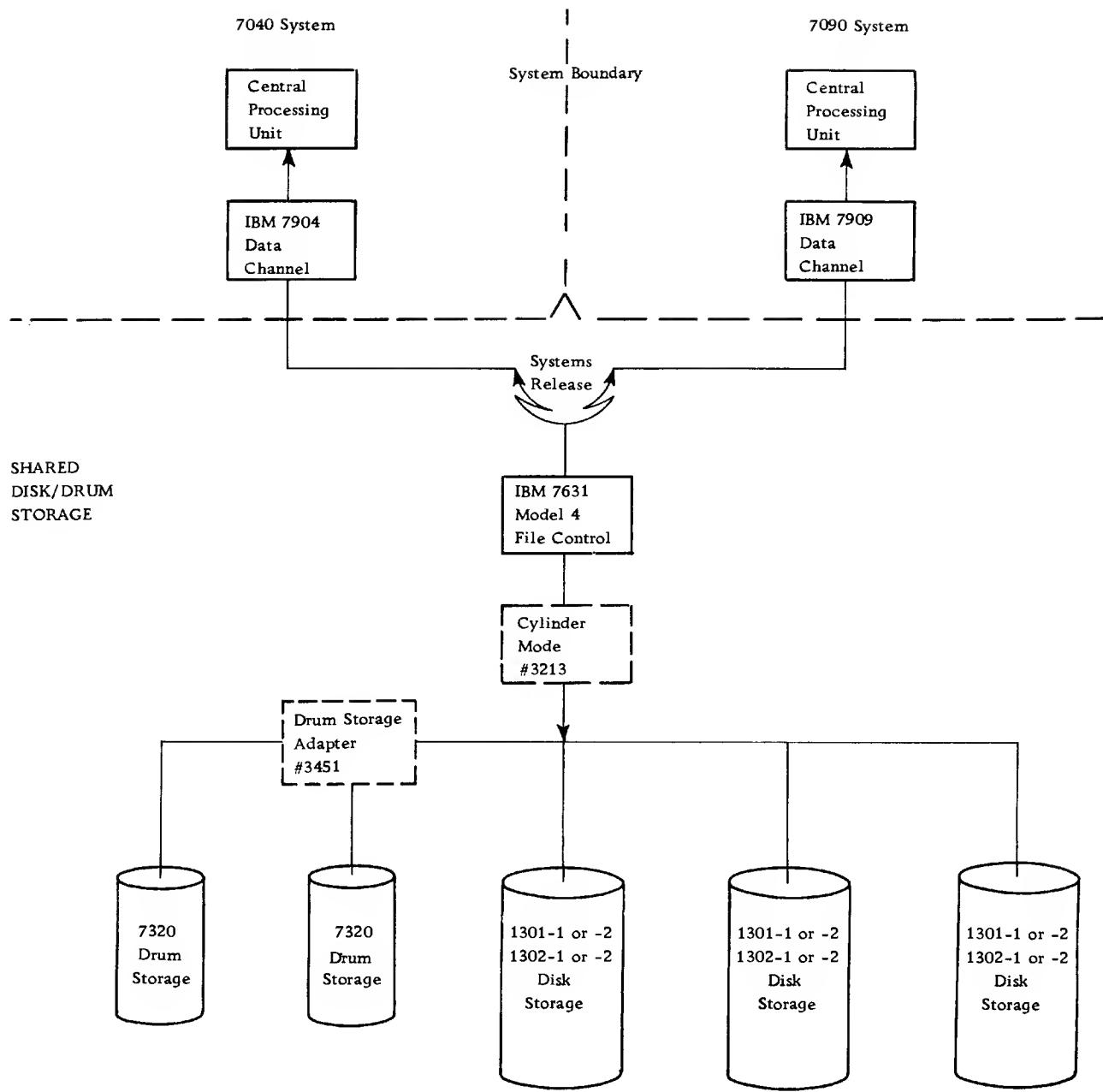


Figure 8. Shared Disk/Drum Storage

Stop: The stop signal is generated by the computer and is transmitted to the file control to indicate the completion of a CPU operation. Upon receipt of the stop signal, the 7631 responds back to the CPU with either an end or unusual-end signal.

#### Error and Unusual Conditions

The twelve error and unusual conditions checked by the 7631 and resulting in an unusual-end signal are:

Parity or Character Check indicates the gain or loss of bits during a read or write check operation.

The 7631 is an odd-parity machine. As characters are transferred from the computer, a vertical parity check is performed. If an even number is detected (indicating an error) a data check bit is produced and set into the status data.

The character code check is made by generating three check characters for each address and record as bits are read from the drum surface during a read operation. The newly generated characters are then compared bit-by-bit with those previously generated and recorded in the gap following each address and each record during the write operation. Failure to compare will indicate the occurrence of an error.

Invalid Address Check occurs if a seek operation is attempted using an invalid address (e.g. above 0399 in drum operations) and a read or write command is given.

Response Check indicates that a character was not received by the 7631 within the allotted time. Response check can only occur as a result of a read or write operation.

Data Compare Check occurs only during a write-check operation. The condition indicates that a compare error was detected somewhere during write check. During a write-check operation, data are read from the drum surface and compared bit-by-bit with those transferred from the computer.

Format Check occurs during either a format write or a write check of a format track. The cause may be either an illegal code (other than a BCD 1, 2, 3, or 4) or because stop signal was not sent to the file control prior to sensing the index point.

No Record Found occurs if the file control fails to locate the track address that was issued to it on a prepare to verify order.

Invalid Sequence can occur in two ways during write operations. In one case, it occurs when a write command is received by the file control without a preceding and properly executed prepare to verify or prepare to write format order. In the second case, invalid sequence occurs when a prepare to write check order is preceded by other than write command. When reading, a prepare to verify is the only legitimate order that can precede a read command.

Invalid Code occurs when the file control is given an order that is not defined for the drum file.

Access/Module Not Ready can be caused by a power-off condition on a 7320 Drum, or the Drum can be in CE mode or off-line.

Drum Storage Circuit Check indicates a circuit failure in the drum storage unit.

File Control Circuit Check occurs because of malfunctioning of the 7631 circuitry.

The status data bits and their assignment in the two sense words are:

| Sense Word | Bit Pos | BCD Bits | Status Indication               | Comment               |
|------------|---------|----------|---------------------------------|-----------------------|
| 1          | 1       | A        | Reserved                        | Summary Byte          |
| 1          | 3       | 4        | Program Check                   | Summary Byte          |
| 1          | 4       | 2        | Data Check                      | Summary Byte          |
| 1          | 5       | 1        | Exceptional Condition           | Summary Byte          |
| 1          | 7       | A        | Invalid Sequence                | Program Check         |
| 1          | 9       | 4        | Invalid Code                    | Program Check         |
| 1          | 10      | 2        | Format Check                    | Program Check         |
| 1          | 11      | 1        | No Record Found                 | Program Check         |
| 1          | 13      | A        | Invalid Address                 | Program Check         |
| 1          | 15      | 4        | Response Check                  | Data Check            |
| 1          | 16      | 2        | Data Compare Check              | Data Check            |
| 1          | 17      | 1        | Parity or Check Char Code Check | Data Check            |
| 1          | 19      | A        | Not Used 7320 Operation         |                       |
| 1          | 21      | 4        | Access/Module Not Ready         | Exceptional Condition |
| 1          | 22      | 2        | Drum Storage Circuit Check      | Exceptional Condition |
| 1          | 23      | 1        | File Control Circuit Check      | Exceptional Condition |
| 1          | 25      | A        | Reserved                        | Data Mode             |
| 1          | 27      | 4        | Six-Bit Mode                    | Data Mode             |
| 1          | 28      | 2        | Reserved                        | Data Mode             |
| 1          | 29      | 1        | Reserved                        | Data Mode             |
| 1          | 31      | A        | Module 0                        | Attention             |
| 1          | 34      | 2        | Module 2                        | Attention             |
| 2          | 1       | A        | Module 4                        | Attention             |
| 2          | 4       | 2        | Module 6                        | Attention             |
| 2          | 7       | A        | Module 8                        | Attention             |

The control panel of the 7631, located on the right front cover, is intended primarily for maintenance purposes. In addition to the exposed section, the control panel has a covered section for customer engineering use. On the exposed section there are 122 indicator lights that reflect status of data and controls within the 7631. The customer engineer section contains 35 switches for simulation of data and machine control. Operator switches are available in a switch and light assembly above the indicator section of the control panel.

#### 7631 SWITCHES AND LIGHTS

Power-On Switch sequentially turns on the ac and dc power to the 7631 and attached 7320's. Depression of this switch, with dc power off, will generate dc power.

Power-On Light turns on when ac power is on in the 7631.

DC-On Light turns on when dc power is on in the 7631.

DC-Off Switch turns off dc power in the 7631 and the 7320.

Power-Off Switch, when depressed, removes dc and ac power from the 7631 and all connected 7320's.

HAO Switch must be in the On position to execute the home address operation

Write Inhibit Switch, when on, allows the customer engineer to perform a write sequence of operations without the actual writing, thus not disturbing customer's data.

Write Inhibit Light is on when the write inhibit switch is on.

Test Mode Light indicates that the 7631 and the attached drum storage units are not available for customer use.

Thermal Light automatically turns on if the internal machine temperature exceeds 115 degrees Fahrenheit; dc power is automatically turned off. DC power can be restored with the operation of the power-on switch after the machine temperature returns to normal operating limits.

Fuse Light turns on and dc power is removed if any auxiliary ac or dc circuit breakers are tripped.

#### 7320 SWITCH

Write Format Track Switch is a key-operated lock switch with a read (RD) and write (WR) position. To position the switch, a key must be inserted and turned. In normal operation, the switch is in the RD position. The switch must be set to the WR position to perform a write format track operation. The position of this switch has no effect on any operation except write format. Each drum module has its individual write format track switch.

## DRUM STORAGE OPERATIONS

Operations performed by the 7631 File Control, 7320 Drum, and IBM 7909 Data Channel are based on the execution of instructions, commands, and orders.

Figure 9 shows the span of control and resulting activities of the execution of instructions, commands and orders in a 7090, 7094 and 7094 II drum storage operation.

### INSTRUCTIONS

Instructions are system-coded information that is decoded and executed by the central processing unit to perform specific operations such as the selection of data channels, resetting and loading of data channels, starting of data channels, etc.

### COMMANDS

Commands are system-coded one-word instructions to the data channel. The commands are decoded and executed by the IBM 7909 Data Channel to perform a specific operation in the data channel or between the data channel and the 7631 File Control.

Four basic commands are executed by the data channel and cause activity in the 7631. The commands are read, write, sense, and control.

Read and write commands set up control circuitry in the 7909 to permit information transmission between the drum storage and the main computer system through the 7631.

Sense commands cause transmission of status data from the 7631 to the main computer system to indicate status conditions existing in the 7631 and the drum storage.

The control command is used to transmit orders to the 7631 and to supply the file control with one or more order words that contain operation and address information.

### DRUM STORAGE OPERATING MODES

Reading and writing of drum storage data may be performed in five modes: home address operations, single record operations, track operations, track without addresses operations, and cylinder operations.

Each mode causes a comparison activity, followed by a transfer of information activity (provided the comparison has been successful). The transfer activity effects transmission of data to or from the drum, according to the mode of data handling involved. The comparison is accomplished by a bit-by-bit confirmation of the address incorporated in the order, as received from core storage, and compared to the actual address selection of the drum

storage. If the comparison is successful, data are transferred to or from specific areas of the drum storage (as determined by the mode of operation involved). If the comparison is unsuccessful, a no-record-found indication and an unusual-end signal are issued to the system by the 7631. A brief explanation of each of the operating modes follows:

Home Address Operation: The physical home address (HA1) is compared with the HA1 in the order, followed by the transfer of the HA2 plus all additional addresses and records on a given track.

Single Record Operation: The record address selected on the drum storage is compared with the record address in the order, followed by the transfer of the associated single record only.

Track Operation: The entire home address (HA1 and HA2) of the selected home address on the drum storage is compared with the home address in the order, followed by the transfer of all record addresses and records on a single track.

Track Without Addresses: The entire home address of the selected track on the drum storage is compared with the home address in the order, followed by the transfer of all data records contained in the remainder of the track.

Cylinder Operation (Optional Feature): The entire selected home address of a particular track in a cylinder is compared with the entire home address in the order, followed by the transfer of all records contained in the particular track and all succeeding tracks of higher address within that cylinder.

### ORDERS

Orders, in the form of characters (Figure 10), are decoded and executed by the 7631 and specify what

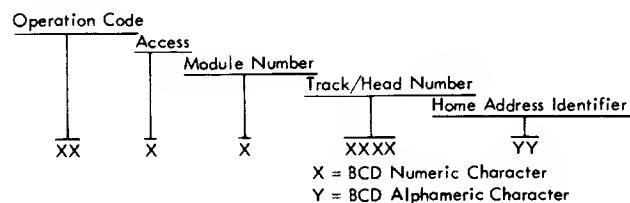


Figure 10. Simplified Order Format

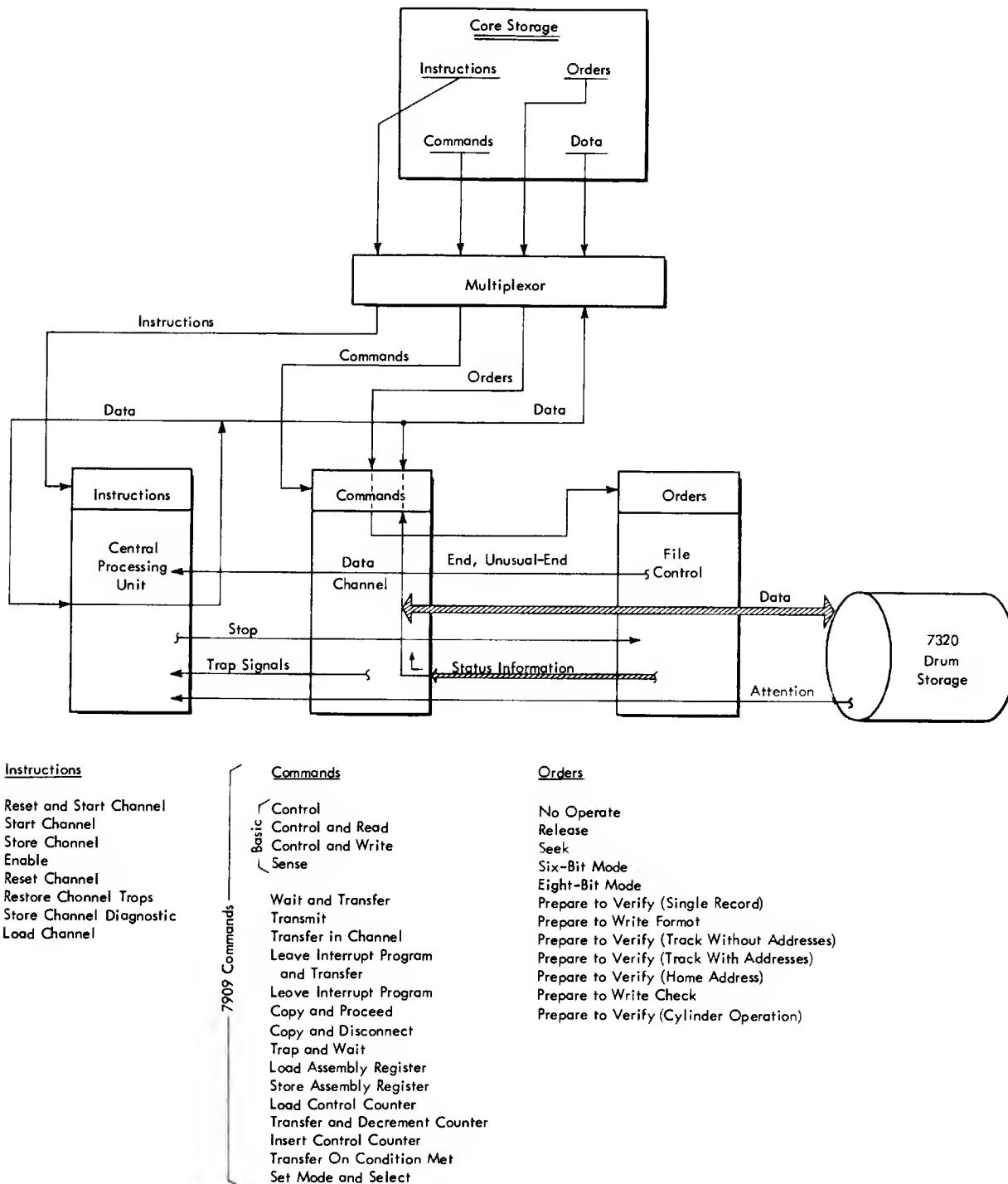


Figure 9. Span of Control – Instructions, Commands and Orders

non-data operations will be performed and where they will be performed in the drum storage. The orders are transmitted from core storage as one or two core storage words, depending on the number of characters required in each order. Some orders require only two characters, other orders require a full complement of ten characters.

Operation Code: This is a two-digit code, expressed as a BCD numeric character. The operation code is all that is required for such operations as no-operation, drum release, eight-bit mode, and six-bit mode.

Access and Module Number: These two positions of the order are always numeric. The access in the 7320 is always referred to as access 0. The module number is determined by the cabling of the 7631.

Record Home Address: The use of these character positions depends on the operation to be performed. In operations in which the address is not required, it is not necessary to use these positions. For operation codes that require addressing of the home address, these positions must contain the track/head number and record number. For operations affecting only a single record, these positions should contain the record address of the desired record. In a checking operation, these positions contain the home address or the record address used in the write operation to be checked.

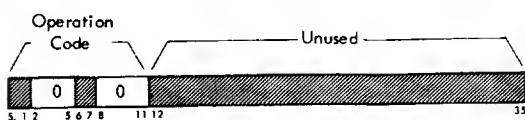
#### IBM 7631 FILE CONTROL ORDERS

The 7631 will decode and execute up to 13 orders transmitted from core storage by the control command. Only 12 of these orders are applicable to 7320 operation; DSAI is not normally used. The 7631 decodes the transmitted order, accepts address information, performs the designated function, and then transmits an end or unusual-end signal to the data channel. At completion of the seek operation, the 7631 sends an attention signal to the data channel.

The 7631 File Control orders for 7320 Drum Storage operations are shown in Figure 11 with mnemonics, operation name, byte configuration, and numeric code.

Some orders require one word in 7090-7094-7094 II core storage, while others require two consecutive locations in core storage. Orders requiring two locations are indicated by an arbitrary symbol and the arbitrary symbol plus one.

#### No Operation (DNOP-00)



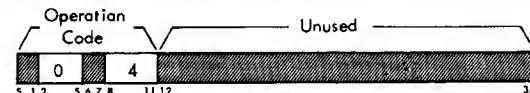
| Mnemonic | Operation                                    | Byte B1<br>8 4 2 1 | Byte B2<br>8 4 2 1 | Numeric Code |
|----------|--|--------------------|--------------------|--------------|
| DNOP     | No Operation                                 | 1 0 1 0            | 1 0 1 0            | 00           |
| DREL     | Release                                      | 1 0 1 0            | 0 1 0 0            | 04           |
| DEBM     | Eight-Bit Mode                               | 1 0 1 0            | 1 0 0 0            | 08           |
| DSBM     | Six-Bit Mode                                 | 1 0 1 0            | 1 0 0 1            | 09           |
| DSEK     | Seek   | 1 0 0 0            | 1 0 1 0            | 80           |
| DVSR     | Prepare to Verify<br>(Single Record)         | 1 0 0 0            | 0 0 1 0            | 82           |
| DWRF     | Prepare to Write<br>Format                   | 1 0 0 0            | 0 0 1 1            | 83           |
| DVTN     | Prepare to Verify<br>(Track without Address) | 1 0 0 0            | 0 1 0 0            | 84           |
| DVCY     | Prepare to Verify<br>(Cylinder Mode)*        | 1 0 0 0            | 0 1 0 1            | 85           |
| DWRC     | Prepare to Write<br>Check                    | 1 0 0 0            | 0 1 1 0            | 86           |
| DVTA     | Prepare to Verify<br>(Track with Address)    | 1 0 0 0            | 1 0 0 0            | 88           |
| DVHA     | Prepare to Verify<br>(Home Address)          | 1 0 0 0            | 1 0 0 1            | 89           |

\* Optional Feature

Figure 11. Drum Storage Orders

Drum Operation: This order requires only a two-digit operation code and is accepted by the 7631 as a programming modification convenience only. No function is performed by the 7631 for this order.

#### Release (DREL-04)



Drum Operation: This order requires only a two-digit operation code and has meaning only for shared system operation. When either system selects and gains control of the 7631, it remains in control of that system until the release order is issued to permit the file control to be available for either system. The 7631 is reset to six-bit mode at the end of each release order.

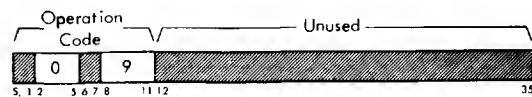
#### Eight-Bit Mode (DEBM-08)



Drum Operation: This order requires only a two-digit operation code and conditions the 7631 to process data in eight-bit mode. The eight-bit mode order is used when data is to be shared with a system designed

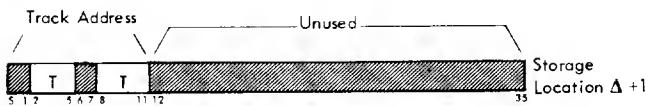
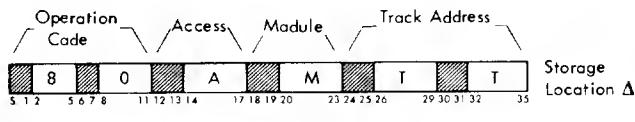
for processing data in eight-bit mode. The 7090-7094-7094 II does not process data in eight-bit mode.

#### Six-Bit Mode (DSBM-09)



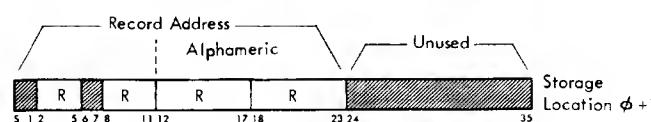
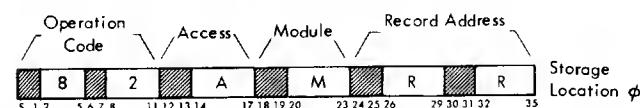
Drum Operation: This order requires only a two-digit operation code and conditions the file control to operate in six-bit mode. The 7090, 7094, 7094 II systems normally process data in six-bit mode. The 7631 is normally in six-bit mode unless programmed otherwise.

#### Seek (DSEK-80)



Drum Operation: This order is used in drum operations primarily for 1301-1302/7320 program compatibility. If a seek is issued to a drum module, an attention signal will immediately be sent back to the computer.

#### Prepare to Verify, Single Record (DVSR-82)



Drum Operation: This order conditions the 7631 for a single-record type of operation and

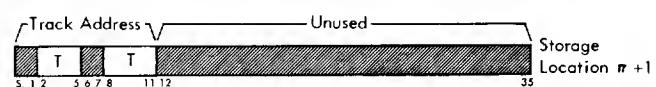
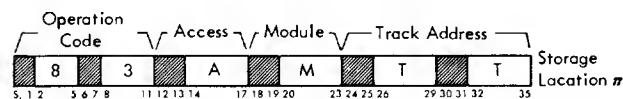
1. Selects the desired module.
2. Specifies the address to be verified.
3. Prepares to transmit data from or to the addressed record in response to a subsequent single-record read or write command.

The order sent to the 7631 is used with the read or write command. Access and module number specify the unit to be selected.

The file control (in single-record mode) compares each record address, as it comes under the read head, with the address furnished by the order until the desired address is found.

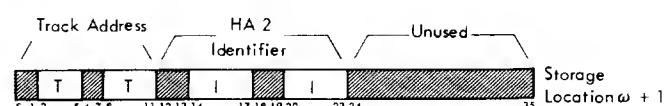
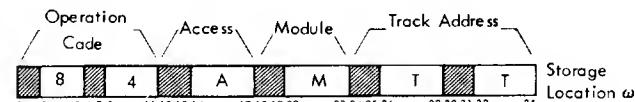
Information can be read from or written into record areas only as defined by the format track. Reading or writing continues until either a stop signal is issued by the computer (write) or the 7631 recognizes the end of record (read).

#### Prepare to Write, Format (DWRF-83)



Drum Operation: This order conditions the 7631 to write a format track for the drum module specified by the address portion of the order (the last two positions of this order are insignificant). To address a format track, the format two-position key-lock switch must be in the write position. To write a format track, DWRF must precede the write command.

#### Prepare to Verify, Track without Addresses (DVTN-84)



Drum Operation: This order, followed by a read or write command, permits reading or writing only the records on a particular track; all addresses are skipped. The address portion of this order must specify the home address.

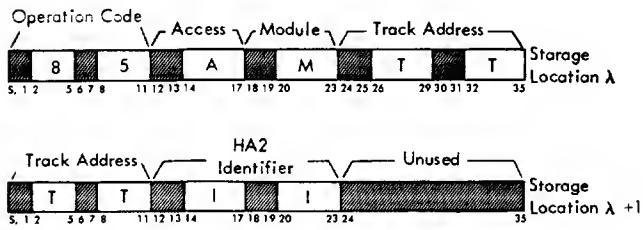
This order instructs the 7631 to:

1. Select the desired module.
2. Supply the home address to be verified.
3. Receive or transmit only the records in response to a subsequent read or write command.

Reading or writing begins at the first record following the home address and continues through the records, skipping addresses, until the computer signals stop or the 7631 recognizes the end of the data areas. Nonverification of the home address

results in a no-record-found indication, with no transmission of data to or from drum storage.

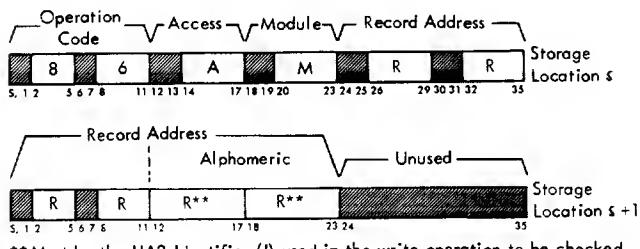
#### Prepare to Verify, Cylinder Operation (DVCY-85)



Drum Operation (Optional Feature): This optional feature permits reading or writing of data (skipping addresses), beginning at the first record after the home address of the addressed track and continuing through successive record locations and tracks of the cylinder until either the end of cylinder is reached or the computer signals a stop. This order is always followed by a read or write command. The following functions are performed in the cylinder operation mode:

1. Select desired module and read/write head.
2. Specify desired home address to be verified.
3. Transmit data after the subsequent read or write command has been given.

#### Prepare to Write Check (DWRC-86)



\*\*Must be the HA2 Identifier (!) used in the write operation to be checked.

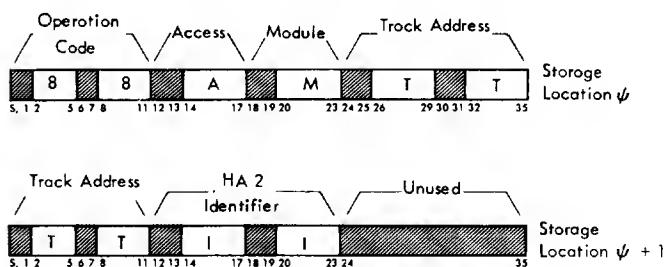
Drum Operation: This order is used with a write command to check any record track or cylinder of tracks of information; it performs a bit-for-bit comparison, comparing the information recorded on the drum with the same information stored in core storage of the computer. If data agree, the order terminates with an end signal; if data disagree, the order terminates with an unusual-end signal. The sequence of commands and orders to write and check recorded data is:

|  |           |
|--|-----------|
| Seek   | -----     |
| Prepare to Verify<br>(Single, Track, Cylinder) | XXXXXXXX* |
| Write  | -----     |
| Prepare to Write Check                         | XXXXXXXX* |
| Write  | -----     |

\*Must be same address

The use of the write check operation is optional depending on the application.

#### Prepare to Verify, Track with Addresses (DVTA-88)



Drum Operation: This order, followed by a read or write command, permits reading or writing a full track of information, including record addresses and records. It makes use of the home address that defines the track address.

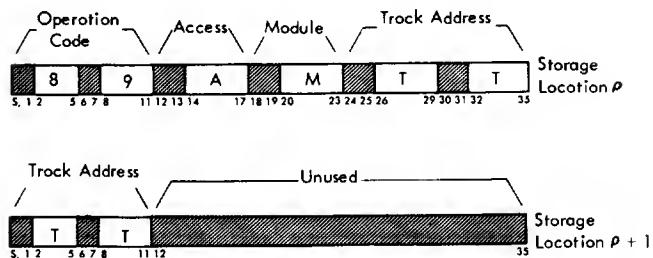
This order instructs the file control to:

1. Select the desired module and read/write head.
2. Supply the home address to be verified.
3. Condition the 7631 to operate on a full-track basis and receive and transmit both record addresses and record areas in response to a subsequent read or write command.

The order is normally used when changes are to be made to record addresses and insertions or when deletions are to be made on a track that contains randomly distributed records.

The execution of this order is similar to that performed by the prepare to verify, cylinder operation, in that only the home address is verified. If verification is successful, reading or writing begins at the following record address and continues through the records and the record address until the computer signals a stop or the 7631 recognizes the end of the data areas. Nonverification of the home address results in no-record-found indication with no transmission of data to or from the drum storage.

## Prepare to Verify, Home Address (DVHA-89)



Drum Operation: This order prepares the 7631 to read or write an entire track of data and addresses including the home address identifier (HA2). The home address must be supplied for subsequent verification. For execution of this order, the home address switch must be on. (The switch is on the 7631 File Control.) This operation is terminated by a stop signal from the computer or when the 7631 recognizes the index point.

## WRITE OPERATIONS

A drum write operation is a processing activity in which information from the computer is transmitted and recorded on the drum surface. The information may be written on a track as data or on a format surface for format control. Data can be transmitted and written in five operating modes:

- Write Home Address
- Write Track with Addresses
- Write Track without Addresses
- Write Single Record
- Write Cylinder (Optional Feature-R-W Cylinder)

All written data can be verified for accuracy and fidelity of recording by a write check operation.

A write command must always be preceded by a prepare to write check, prepare to write format, or a prepare to verify order. A write command not preceded by one of these orders is terminated with an invalid-sequence indication with no transmission of data to the file control. (A no operation order can be inserted between prepare to and write commands.)

### Write Format Track

To write a format track, three conditions must be met:

1. The format switch must be in the write position; otherwise, no writing of the format track will take place.
2. A prepare to write format order with a track address of one of the tracks must be received and normally terminated by the 7631.
3. The prepare to write format order must be followed by a write command specifying a core

storage location that contains the field of BCD characters used to write a format track.

### Write Home Address

The conditions necessary for this operation are: the home address switch on the 7631 is on, a prepare to verify home address order is issued to the file control; and the write command immediately follows. The file control compares the physical address portion of the home address on the track and begins the write operation at the beginning of the HA2 area.

The first characters must be the home address identifier of the particular track. The home address identifier must be a minimum of two characters. If desired, this area may be extended to six characters to match the word length of the 7040 and 7044 systems. The number of characters requested by the 7631 for the home address identifier is determined by the number of BCD 1's previously written on the format track. All characters of the home address identifier after the second are nonsignificant and are not a part of address compare operations.

This operation continues with the file control detecting the gap between HA2 and the first record address. On detection of the gap, the file control writes the three-digit check character. The operation continues writing record addresses and records to the end of the track. If a stop signal occurs before the end of the track is sensed, data transmission stops but the file control continues writing blanks to the end of the track. A write home address operation is mandatory every time the format track is changed.

### Write Track with Addresses

Conditions necessary for this operation are a prepare to verify track with addresses order, followed by a write command. Under control of the prepare to verify track with addresses order, the file control searches the data track for a home address and compares this address bit-for-bit against the address previously issued with the prepare to verify track with addresses order. If the home address fails to compare (both HA1 and HA2 are compared, including all bits of the HA2), the file control issues an immediate unusual end and indicates in its status word a no-record-found bit. On a successful home address compare, the file control transfers the record address and proceeds in the usual manner. The file control continues filling the record area with data (both records and addresses) from the computer. The file control also supplies the check characters to be written at the end of each area. When the last check character area is reached, a normal end will

be issued to the computer if no error conditions have been detected; otherwise, unusual end results. If the computer signals a stop in the middle of a record, data transmission stops, but the file control writes blanks to the end of the record area in which it is operating, writes the check characters, and signals normal end or unusual end.

#### Write Single Record

The conditions necessary for this operation are that a prepare to verify order is issued to the file control, followed by a write command. The record address area is recognized in the file control by sensing the end of a long gap in the format. On finding a record address area, the file control reads off the address contained in the area and compares it bit-by-bit with the address previously supplied to the 7631 during prepare to verify single record. If the address does not compare, the file control continues searching succeeding address areas and comparing the address contained in each. If the file control passes the index point twice without comparing the address, it registers the no-record-found status bit and issues an unusual end to the computer without transmission of data. On an address-compare-true, the file control causes the drum to write over the record immediately following the compared address. Data are furnished by the system. The file control automatically transmits the code check characters following the end of the record area as defined by the format track.

If a stop signal is received at some point in the record area, the file control continues to write the record, with blanks, until the end of the formatted area is reached. After the check characters are recorded, a normal end is issued to the system unless a data check has occurred, in which case unusual end would result.

#### Write Track without Addresses

The conditions necessary for this operation are a prepare to verify track without addresses order, followed by a write command. The address received with the prepare to verify track without addresses order is compared with the home address transmitted from the drum (both HA1 and HA2, including all bits of the HA2). If the home address fails to compare, the no-record-found bit is registered and unusual end is issued to the system. If the address compares true, the file control skips the first address area into the record area and writes the record. The file control continues skipping addresses and writing the records until the end of the last record on the track is sensed. A normal end is issued to the system if no error conditions occur during data transfer. In

case of a parity error, the operation will be terminated at the end of the record in which the error was detected and unusual end is issued.

If the computer signals a stop in a record, data transmission stops, but the file control continues writing blanks to the end of the record area in which it is operating, then writes the check characters and signals normal end or unusual end.

#### Read or Write Cylinder

Operation in the cylinder mode is an optional feature of the 7631. A cylinder mode read or write is set up by having the computer send a prepare to verify cylinder operation order to the file control. The address issued with the order is the home address of the track on which the operation is to start. The complete home address (HA1 and HA2) is compared bit-by-bit in the 7631 after the read or write is received. All bits of HA1 and HA2 are compared.

On a compare equal, the data transfer operation begins with all records on the addressed track being read or written and with the record addresses ignored in the same manner as a track without addresses operation. Rather than causing an end signal when the last record of the track has been processed, the 7631 sends a new head address to the drum, and reading or writing continues. The head address sent to the drum is one address higher than the previous head address. By indexing one head address on each disk revolution, the 7631 continues reading or writing until the entire cylinder of information has been processed. The end signal is generated in the 7631 when the highest-order head of the cylinder has been operated on.

If the computer signals a stop in a record, data transmission stops; but, if reading, the file control continues to the end of record and then compares check characters. If writing, the file control writes blanks to the end of the record in which it is operating, then writes the check characters and signals normal end or unusual end.

No wrap-around feature is included in cylinder operation to cause operation to begin again at the low-order head after the high-order head has completed its reading or writing.

#### Write Check

Each write operation has an associated write check operation, the use of which is optional and under program control. The operation requires the following sequence of orders and commands:

|                        |         |
|------------------------|---------|
| Prepare to Verify      | XXXXXXX |
| Write                  | -----   |
| Prepare to Write Check | XXXXXXX |
| Write                  | -----   |

The 7631 compares the data recorded in the addressed record, bit-by-bit, with the write data from the system, at the same time generating check characters that will be compared with those previously generated and recorded on the track. The end of this operation is the same as a standard write operation. A compare error during a write check sets the data-compare check bit in the status data.

During a write check operation on a format track, the format gap detector circuits in the 7631 are checked to determine if they are within their specified tolerance. A file control circuit check is noted if the circuits do not meet specifications.

On receipt of a stop signal, the 7631 compares up to and including the last character received, then continues reading until the end of the record area and issues a normal-end or unusual-end signal.

## READ OPERATIONS

A drum read operation is a processing activity in which data recorded on the drum surface are retrieved and transmitted to the computer. Data may be read and transmitted to the computer in five operating modes:

- Read Home Address
- Read Track with Addresses
- Read Track without Addresses
- Read Single Record
- Read Cylinder (Optional Feature-R-W Cylinder)

### Read Home Address

This operation requires that a prepare to verify home address order is sent to the 7631 and that a read command follows. The most useful application of this operation is to recover tracks of information in a file-dump operation. The 7631 compares the physical address portion of the home address and begins reading with the home address identifier. All address and record data of the track are read. The termination of this operation occurs when the 7631 senses the index point. At that time either normal end or unusual end is issued, depending on the state of the data check. The computer may terminate the operation earlier by issuing a stop. On receipt of the stop, the 7631 terminates data transmission and internally completes reading the record on which it was operating at the time of the stop. At the end of the particular record, the 7631 sends either normal end or unusual end, depending on the state of data check. The read home address operation is particularly useful in the event data must be retrieved after an undesired erasure of the format track.

### Read Track with Addresses

Conditions necessary for this operation are that a prepare to verify track with addresses order is issued to the 7631, followed by a read command. The file control begins the operation by comparing the home address that accompanied the prepare to verify track with addresses order against the recorded home address on the selected track. A failure to compare causes a no-record-found signal to be set in the status data and causes an unusual end to be issued to the system. A successful compare permits the 7631 to begin reading at the first record address area. The record address is read out in its entirety and sent to the system, followed by the record, and then the next address and record, etc. The operation terminates when the 7631 senses that it has completed comparing the check characters of the last record of a track. At that time, a normal end or unusual end is issued, depending on the state of data check. A stop signal before the logical end of this operation causes the 7631 to stop data transmission and signal a normal end at the end of the record it is operating on at the time of the stop signal.

### Read Single Record

This operation requires completion of a prepare to verify single record order and read command. As with write (single record) operation, the read (single record) operation has no predetermined starting point on the drum; that is, when the instruction is received by the 7631, it immediately begins searching for a record address. On finding one, the 7631 does a bit-by-bit comparison. A failure to compare causes the control to continue searching on the next record address. No record found is registered if the 7631 passes the index point twice in its search for a particular record. On obtaining an address confirmation, the 7631 causes the record immediately following that address to be read and the data to be sent to the system. The 7631 verifies the legality of the check characters following the end of the record and sends the normal end or unusual end at that time. A stop signal before the logical end of this operation causes the 7631 to stop data transmission and to signal a normal end or unusual end at the end of the record.

### Read Track without Addresses

This operation requires that a prepare to verify track without addresses order and a read command, in that sequence, be executed. The 7631 waits for the home address area before beginning to compare the address supplied with the prepare to verify order with the recorded home address. A compare failure causes

the 7631 to register no record found in the status word. If the address compares successfully, 7631 carries out the read-track operation by skipping over the first record address and reading the first record. The operation continues with addresses ignored by the 7631 and only record data being sent to the

system. The operation ends when the 7631 finishes the last record of the track. At that time the appropriate end signal is issued. An early end may occur because of a system stop signal. In that case, the 7631 finishes the record in which it is operating and issues a normal end or unusual end, as the case may be.

The following procedures form the basis of the error recovery routines used in IBM Programming Systems applied to IBM 1301 and 1302 Disk Storage and 7320 Drum Storage operation. For efficient utilization of IBM 7090, 7094, 7094 II Data Processing Systems, the use of these error recovery procedures is recommended in writing routines involving the 1301, Models 1 and 2, the 1302, and the 7320.

Figure 12 shows the 7631-1301/1302, 7320 error conditions that can occur in 7090, 7094, 7094 II Data Processing Systems operation and specifies the minimum action recommended upon the encounter of the error conditions. All data check error conditions should be examined and handled before correcting program-check and exceptional-condition error conditions.

#### Action 1

1. Repeat the original sequence (that is, prepare to verify order and subsequent read or write command) once.
2. If the error condition still occurs, print message type 1.

#### Action 2 (For Combined 1301-1302/7320)

1. Repeat the original sequence (that is, prepare to verify order and subsequent read or write command) four times.
2. After the fifth error indication, issue a DSEK order (using any of addresses 9 @ 00 to 9 @ 39).

Note: The @ is a convenient method of addressing the customer engineering (CE) track, which is used in access arm recalibration on the disk storage.

The seek order, addressed to module 2 and track 39, would appear (in binary) as shown in Figure 13. The binary representation shows how the order would appear in the two required locations of core storage.

#### 1301/1302 Activity

1. When a 1301/1302 is addressed, the DSEK (9 @ 00 to 9 @ 39) causes the access mechanism to be recalibrated by going to the CE track.

| Sense Bit Assignment | 7090-7094-BCD Bit        | 7094 II Bit Pos      | Status Condition  | Comment  | When Encountered During a Read Operation 1301-1302-7320             | When Encountered During a Write or Write Check Operation 1301-1302-7320 | When Encountered During a Control Operation 1301-1302-7320                |
|----------------------|--------------------------|----------------------|---|--|---|---|---|
| A<br>4<br>2<br>1     |                          | 1<br>3<br>4<br>5     | Reserved<br>Program Check<br>Data Check<br>Exceptional Condition                                      | Summary Byte   |   |   |   |
| A<br>4<br>2<br>1     |                          | 7<br>9<br>10<br>11   | Invalid Sequence<br>Invalid Code<br>Format Check<br>No Record Found                                   | Program Check<br>Program Check<br>Program Check<br>Program Check             | Action 1<br>Not Applicable<br>Not Applicable<br>Action 2            | Action 1<br>Not Applicable<br>Action 1<br>Action 2                      | Not Applicable<br>Action 1<br>Not Applicable<br>Not Applicable            |
| A<br>4<br>2<br>1     | Part of First Sense Word | 13                   | Invalid Address   | Program Check  | Action 4  | Action 4  | Not Applicable for 1301-1302;<br>Action 4, 7320                           |
|                      |                          | 15                   | Response Check  | Data Check   | Action 1  | Action 1  | Not Applicable  |
|                      |                          | 16                   | Data Compare Check  | Data Check   | Not Applicable  | Action 3  | Not Applicable  |
|                      |                          | 17                   | Parity or Check Char  | Data Check   | Action 3  | Action 3  | Action 1  |
| A<br>4<br>2<br>1     |                          | 19<br>21<br>22<br>23 | Access Inoperative<br>Access (Module) Not Ready<br>1301-1302-7320 Circuit Check<br>7631 Circuit Check | Exceptional Cond<br>Exceptional Cond<br>Exceptional Cond<br>Exceptional Cond | Action 1 (Not Applicable, 7320)<br>Action 1<br>Action 1<br>Action 1 | Action 1 (Not Applicable, 7320)<br>Action 1<br>Action 1<br>Action 1     | Action 1 (Not Applicable, 7320)<br>Action 1<br>Action 1<br>Not Applicable |

Figure 12. Error Conditions and Actions Required--7631, 1301-1302, 7320

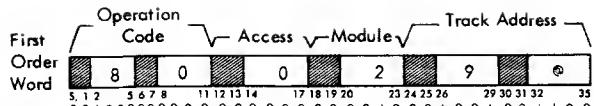


Figure 13. DSEK Order

2. Upon recalibration, issue a DSEK to any valid address. (This positions the access mechanism to cylinder 0.)
3. Issue DSEK to the original error-producing address.
4. Repeat the prepare to verify order and read/write command sequence four times.
5. After the ninth error condition occurs, print message type 1.

#### 7320 Activity

1. If a 7320 is addressed, the DSEK (9 @ 00 to 9 @ 39) will result in an unusual end (invalid address indication).
2. Issue DSEK to the original error condition producing address.
3. Repeat the prepare to verify order and read/write command sequence four times.
4. After the ninth occurrence of the error condition, print message type 1.

#### Action 2 (For 7320 Only Error Recovery Routine)

1. Repeat the original sequence (prepare to verify order and read/write command) four times.
  - a. Issue DSEK to the original error condition producing address.
  - b. Repeat the prepare to verify order and read/write command sequence four times.
  - c. After the ninth occurrence of the error condition, print message type 1.

#### Action 3

1. Repeat the original sequence (prepare to verify order, read/write command) four times. (For write check, the sequence is: prepare to verify, write, prepare to verify, write check.)
2. After the fifth occurrence of this error condition, print message type 1.

#### Action 4

1. Issue a DSEK order to any valid address.
2. Reissue the original DSEK together with the prepare to verify order and read/write command one time.
3. If the error condition continues, print message type 1.

#### Message Type 1

Message type 1 identifies an uncorrectable error and is used as a diagnostic aid. Further use and procedure are determined by the application involved.

#### Message Type 1 Format

Minimum: Items 1 to 3, inclusive.  
Recommended (if core storage permits): Items 1 to 7, inclusive.

Maximum: Items 1 to 9.

1. Type of error: Read, write, write check or control.
2. Unit involved: Access number, module number, track number.
3. File control status word: Bytes 0 to 4, inclusive. An examination of byte 0 will reveal any multiple error conditions.
4. Channel designation and final status or control word for the channel at the time of the error.
5. File control status word: Bytes 5 to 9, inclusive.
6. Nature of data: Packed or unpacked (7090, 7094, 7094 II do not operate in packed mode).
7. Preceding control orders.
8. Previous unit involved: Access number, module number, track number, FROM address (the preceding address sought on the module in error).
9. Current unit involved: Access number, module number, track number, TO address (the address to which the access was going, or which it had reached, at error time).

#### Message Type 2

This message provides statistical print-out at the end of a program segment or run, or at some convenient time.

#### Message Type 2 Format

1. Access number, module number.
2. Number of entries into error routine.
3. Number of type 1 messages printed.

COMMENT SHEET

IBM 7320 DRUM STORAGE WITH IBM 7090, 7094, 7094 II DATA PROCESSING SYSTEMS

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